"SYNTHESIS AND CHARACTERIZATION OF YTTRIUM DOPING IN Ni-Cu NANOFERRITES BY SOL-GEL TECHNIQUE"

SYNOPSIS

SUBMITTED TO THE

SWAMI RAMANAND TEERTH MARATHAWADA UNIVERSITY

VISHNUPURI, NANDED, MAHARASHTRA

FOR THE DEGREE

OF

DOCTOR OF PHILOSOPHY

IN

PHYSICS

By

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Year- 2017

SWAMI RAMANAND TEERTH MARATHAWADA UNIVERSITY

VISHNUPURI, NANDED, MAHARASHTRA

TITLE OF THE RESEARCH WORK	**SYNTHESIS AND CHARACTERIZATION OF YTTRIUM DOPING IN Ni-Cu NANOFERRITES BY SOL-GEL TECHNIQUE**
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PROPOSED WORK/PROBLEM:

"SYNTHESIS AND CHARACTERIZATION OF YTTRIUM DOPING IN Ni-Cu NANOFERRITES BY SOL-GEL TECHNIQUE"

Abstract:-

A simple, effective and low temperature method use to investigate the effect of rare earth element Yttrium substituted in Ni-Cu nanoferrite as $(A)_x$ $(B)_y$ $Fe_{2-y}O_4$ where A is combination of Ni, Cu metal oxide and B is rare earth metal oxide (Yttrium) (where as x = 1 and y= 0.025, 0.05, 0.075, 0.1, 0.125) prepare by sol-gel autocombustion method. All materials are in nitrate forms. The prepared sample characterized by TGDT will be analyze for the phase formation, FT-IR for confirmation of ferrites, UV-Visible for absorption spectra, SEM for surface morphology and XRD for determination of particle grain size and structural properties of the prepared samples. The dielectric permeability, AC resistivity and DC resistivity will be measure. VSM is used to study the magnetic properties of prepared nanoferrites. TEM will be used to find plane, particle size and radii. This research work is expected to enhance the magnetic and electrical properties of the materials. The prepared samples have various applications in core material, electronic devices technology and sensor. It is important to study the effect of Yttrium substituted in nanoferrite physics at low dimensions and it has potential of applications in the ferrite based devices. Hence, it is decided to carry out detail synthesis and characterization to study of Ni-Cu nanocrystalline powder with effect of rare earth Yttrium substituted using sol-gel method.

In brief survey, it is found that few researchers have works on this ferrite material. Therefore, it is important to study the Physics at low dimensions and it has potential of applications in the ferrite based devices. Hence, it is decided to carry out detail synthesis and characterization study of Ni-Cu nanocrystalline powder by substituted rare earth Yttrium using sol-gel method.

1. INTRODUCTION:

Nanotechnology is the technology to make things small, light and cheap. Nanotechnology is the study of manipulating matter on an atomic and molecular scale which deals with structures sized between 1 to 100 nm and involve developing materials or devices possessing at least one dimension within this size. Quantum mechanical effects are very important at this scale which is in the quantum realm. Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale. Nanotechnology may be able to create many new materials and devices with a vast range of applications such as in medicine, electronics, biomaterials and energy production etc. The Built to atomic specification, the products would exhibit order of magnitude improvements in strength, toughness, speed, efficiency, quality and cost.

Ferrites are electrically non-conductive ferrimagnetic ceramic compound materials which consisting of various mixtures of iron oxides such as Hematite (Fe_2O_3) or Magnetite (Fe_3O_4) and other metals oxides. The general form of ferrite is MFe_2O_4, where M represents a divalent metal ion like Mn, Fe, Mg, Co, Cu, Ni, and Zn. Ferrites are predominantly ionic and have very stable crystal structure which contains iron oxides as major constituents but based on Cr, Mn and other elements. Ferrite nanoparticals have attracted an increasing interest because of their scientific aspects and applications in permanent magnets, targeted drug delivery, and high density information storage devices. Ferrite cores are used in electronic inductors, electro-optic modulators, hydroelectric detector, piezoelectric sensors, gas sensors, electronic sensors, high quality filters, transformer cores, ferrite isolators, memory core industry, multiplayer chip inductor, rod antennas, radio frequency circuits and electromagnets where the high electrical resistance of the ferrite leads to very low eddy current losses. They are commonly seen as a lump in a computer cable called a ferrite bead which helps to prevent high frequency electrical noise (radio frequency interference) from exiting or entering the equipment. For these reasons, their applications ranges from simple function devices, such as small permanent magnets to sophisticated devices for the electronic industry. Some interesting applications are in magnetic media used in computers, recording devices, magnetic cards and tapes. The electrical and

magnetic properties of ferrites are depending on the processing conditions, sintering temperature, chemical composition and types of additives.

2. REVIEW OF LITERATURE AND DEVELOPMENT IN SUBJECT:

M. Shobana et al [1] made an attempt to study the *yttrium doped cobalt ferrite* by using sol-gel autocombustion technique. The structural characterization results the formation of a pure single phase and nanosize crystallites. In addition, their magnetic properties can be controlled and tailored for practical applications through the appropriate choice from a number of divalent cations in their structure.

Ramadan shaiboub et al [2] studied the physical properties of $Er_xY_{3-x}Fe_5O_{12}$ nanoparticle films (x= 0.0 , 0.6, 1.2,2.0 and 2.5) have been synthesized by a sol-gel technique. All the sample were annealed at 1000^0C . The nanostructures were characterized by an X-ray diffraction. XRD spectra of all the samples show single phases with diffraction lines (hkl) corresponding to the cubic garnet structure. The sizes of the particles are in the range of 78nm to 89nm . The magnetic properties was studied using VSM shows that the saturation magnetization is reduced with Er substitution . The coercivity of the films is maximum for x= 1.2. it was observed that the average particle size measured by FESEM is bigger than crystalline size measured by Scherrer's formula . This means that the particle are not single crystal and may consists of 2 or 3 more crystallites.

Kolekar et al [3] was examined the effect of trivalent substitution in different ferrites to improve their structural, magnetic and electrical proprieties. The effect of the *substitution of* Gd^{3+} on the thermoelectric power of Cu-Cd ferrite was examined using sol-gel autocombustion technique.

Bhise R.B. et al [4] has reported the effect of Y^{+3} substitution on $Ni_{0.4}$ $Mg_{0.4}Cd_{0.2}$ Fe_{2-Y} O_4 (where Y= 0.025 to 0.125) was prepared by sol – gel auto combustion technique and sintered at 400 ^{0}C for duration of 2 hrs . The analysis of XRD pattern revealed the formation of single phase cubic spinel structure . The average grain size was found to be between 17 to 24.3 nm. The XRD pattern also shows that nanoparticles size decreases with the increase in Y^{3+} content. The dielectric properties have been studied as a function of frequency (100 Hz to 5MHz) at room

temperature using LCR meter. For each sample the dielectric constant decreases with increase in frequency. TG-DTA analysis of the auto combusted ferrites was carried out with a heating rate of 10 ^{0}C /min in air . From TGA analysis it is observed that as temp increases the percentage weight loss decrease . From DTA analysis we observed that with increase in temp the voltage increases up to 350 ^{0}C and it decreases with the increases in temp.

Nandu Chaure et al [5] has reported Nanostructured *Mg-Ni-Zn ferrite* with composition $Mn_{0.1}Ni_{0.6}Zn_{0.3}Al_xFe_{(2-x)}O_4$ (where x =0.05, 0.1, 0.15, 0.2) was prepared by *sol-gel method*. X-ray diffraction (XRD) patterns of all samples showed the spinel structure. Further, the XRD data have been used to calculate the lattice parameter and grain size. The morphology of nanoferrites was studied using scanning electron microscopy. The dielectric permeability, AC and DC resistivity for all compositions were measured. The highest resistivity was measured for the sample with x = 0.1. Vibrating Sample Magnetometry (VSM) was employed to study the magnetic properties of nanoferrites. High saturation magnetization of value 38.7 emu/g, coercivity 7 Oe and highest initial permeability 83.7 was measured for the sample consisting Al concentration, x = 0.05. These nanoferrites may have applications in core materials and in electronic device technology.

Aurelija Gatelyte et al [6] made an attempt to study transition metal nanoferrites ($YFeO_3$, $Y_3Fe_5O_{12}$, $CoFe_2O_4$, $NiFe_2O_4$ and $ZnFe_2O_4$) by using sol – gel auto combustion method. The present study demonstrates the versatility of the solution method to yield mono phasic transition metal ferrites at low sintering temperature (up to 1000^{0}C). Powder characterization was carried out by X-ray diffraction (XRD) to evaluate crystallographic analysis and crystallite size; The microstructural evolution and morphological features of obtained transition metal ferrites were studied by scanning electron microscopy (SEM). The phase purity of synthesized nano-compounds was characterized by infrared spectroscopy (IR) .

Z.H. YANG et al [7] reported *$Ni_{0.23}Cu_{0.11}Zn_{0.66}Fe_2O_4$ ferrite* flakes, with thickness of about 8 μm and average diameter of 20–35 μm, were prepared using a sol–gel bubble method. Morphology, phase evolution, static and dynamic magnetic properties of the flakes and their composites were studied. Magnetic measurements showed that easy magnetization direction of

the flaky filler composite was parallel to its sample plane. This *sol–gel method* should be also applicable to fabricating flakes of other multi-component oxides.

M. Siva Ram Prasad et al [**8**] described $Ni_{0.65-x}Cd_xZn_{0.35}Fe_2O_4$ ferrites with x varying from 0.00 to 0.20 in steps of 0.04 have been prepared by conventional ceramic route. Calcination and sintering of samples were performed at 950 and 1250 ^{0}C for 4 and 2 h, respectively. The prepared samples were characterized by powder X-ray diffraction. The observed modifications in structure and increase in lattice constant are attributed to the difference in ionic radius of substituted Cd^{2+} ion and displaced Ni^{2+} ion.

Hong-guo Zhang et al [**9**] reported a series of *Co ferrites* ($Co_xFe_{3-x}O_4$(x¼-0.1)) were prepared using solid-state method in this work. The aging effect of their structures and constrictions of hysteresis loops under low magnetic field were investigated. It was found that during the aging process, the migration of trivalent (bivalent) ions between tetrahedral (A-site) and octahedral (B-site) coordination induced a shrinking of the lattice, which would expand again due to the precipitation of $Fe3^+$ after a much longer aging time.

A.K.M. Akther Hossain et al [**10**] studied structural and magnetic properties of *Cu substituted* $Ni_{0.50-x}C_xZn_{0.50}Fe_2O_4$ ferrites (where x¼ 0.0–0.25) prepared by an *autocombustion method* have been investigated. The X-ray diffraction patterns of these compositions confirmed the formation of the single phase spinel structure. The particle size of the starting powder compositions varied from 22 to 72 nm. The theoretical density increases with increase in copper content whereas the Neel temperature decreases. The bulk density, grain size and permeability increases up to a certain level of Cu^{2+} substitution, beyond that all these properties decrease with increase in Cu^{2+} content. The bulk density increases with increase in sintering temperatures up to 1250^{o}C for the parent composition, while for substituted compositions it increases up to 1200^{o}C. Due to substitution of $Cu^{2+,}$ the real part of the initial permeability increases from 97 to 390 for the sample sintered at 1100^{o}C and from 450 to 920 for the sample sintered at 1300^{o}C.

S. Da Dalt et al [**11**] investigated the *solution combustion synthesis* technique to obtain the nanostructured *magnesioferrite (*$MgFe_2O_4$) spinel powder. The reaction was performed in an electric muffle furnace. Considering the characteristics of the as-synthesized powders, the 30% fuel-deficient formulation was selected for synthesis temperature evaluation. This formulation was synthesized at different furnace temperatures. Powder characterization was carried out by X-ray diffraction (XRD) to evaluate crystallographic analysis and crystallitesize; Transmission

Electron Microscopy (TEM) was done to assess the morphology and crystallite size; and Mössbauer spectroscopy and vibrational sample magnetometer (VSM) were performed to obtain magnetic measurements.

Xiaoyan Tan et al [**12**] described *nanocrystalline* $Ni_{0.5}Cu_{0.5}Fe_2O_4$ was synthesized by *sol–gel method* with varying calcination temperature over the range of 500–1000. The powders obtained were characterized by X-ray diffraction (XRD), Fourier transform infrared (FT-IR), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). In addition, thermal analysis (TG–DTG–DTA) of the precursor was carried out. For the crystalline structure investigated, single cubic spinel is gained when the precursor was decomposed at 800–1000, whereas separated crystal CuO formed when calcination temperature is below 800. The increase of calcination temperature favors the appearance of $FeB^{3+,}$ CuA^{2+} and O on the spinel surface.

Jitendra Pal Singh et al [**13**] investigated the swift heavy ion irradiation induced effects in zinc ferrite nanoparticles through X-ray diffractometry, transmission electron microscopy and electron paramagnetic resonance spectroscopy. A series of zinc ferrite nanoparticles having different crystallite sizes ranging from 12 to 62 nm have been *synthesized by using the nitrates of cations and the citric acid* as the host. These samples were irradiated by 100 MeV oxygen beam with two fluences 1-1013 and 5-1013 ions/cm^2. The XRD patterns show the deterioration of crystalline phase after irradiation. The average crystallite size decreases after irradiation. EPR analyses of the pristine and irradiated samples show that the changes depend on the average crystallite size of the pristine samples.

P.B.C.Rao et al [**14**] described *Nickel-zinc ferrites* of different compositions $Ni_{(1-x)}Zn_{(x)}Fe_{(2)}O_{(4)}$ with x = 0.40, 0.50, 0.60 and 0.70, have been prepared by a precursor method involving citrate precursors of the concerned metals and mixing them in solution state. Resistivity has been studied as a function of composition and sintering temperature. It is observed that NiZn ferrites prepared by this method *have resistivity* ≥ 10~(8) Ωcm which is higher by at least two orders of magnitude than that reported (≤10~(6) Ωcm) for ferrites prepared by the conventional ceramic method. This is attributed to better purity as well as better compositional and microstructural control achievable by the citrate method. High resistivity makes these ferrites suitable particularly for high-frequency applications where eddy current losses are required to be low.

Ningjie Chu et al [**15**] investigated low *Mn-doped NiCuZn ferrites* with compositions of $(Ni_{0.6}Zn_{0.3}Cu_{(0.1)1-x}Mn_xFe_2O_4$ (where x = 0, 0.01, 0.02 and 0.03) were synthesized directly with *sol–gel method*. The influence of the Mn^{2+} content (parameter x) and the sintered temperature on the microstructure and the magnetic properties of these ferrites were mainly discussed. With the increasing Mn^{2+} content, saturation magnetization (Ms) of the powder samples decreased.

Jung-Sik Kim et al [**16**] reported the ultra-fine *NiCuZn-ferrite* was prepared by a coprecipitation method. The magnetic properties were investigated in terms of calcining temperature. The ferrite powders, $Ni_{0.206}Cu_{0.206}Zn_{0.618}Fe_{1.94O4-d}$, were initially heat treated at various temperatures of 300–750^oC, and then sintered at the final temperature of 900^oC. The average particle size calculated by a XRD pattern and confirmed by a transmission electron microscope (TEM) micrograph was 7.5 nm. The calcining temperature was an important factor for microstructures and magnetic properties of the sintered ferrite. Scanning electron microscope (SEM) micrographs showed a uniform grain growth with small pores and high densification at the calcining temperature of 450^oC.

J. Hu, M. Yan et al [**17**] studied that this $(Ni_{0.21}Zn_{0.58}Cu_{(0.23)}\ Fe_{1.95O4}$ ferrite was prepared by *sol–gel method*. It was found that the calcination were effective to remove the residual and other phases arising from the inadequate combustion of the gel, which promoted the solid-reaction in the *sintering process* and finally led to a denser and more uniform microstructure of the sintering body.

Xiwei Qi et al [**18**] described that nanosize *$LaFeo_3$ powders* of 30 nm particle size were directly prepared by *sol-gel auto-combustion* at room temperature. The overall process involves three steps: formation of homogeneous sol; formation of dried gel; and combustion of the dried gel. Experiments revealed that $LaFeO_3$ dried gel derived from citrate and nitrate sol exhibits self-propagating combustion at room temperature once it is ignited in air. After auto-combustion, the gel directly transforms into nanosized $LaFeO_3$ particles.

D. S. BIRAJDAR et al [**19**] reported that the structural, IR and magnetic properties of the mixed *spinel $Cu_{1+x}Mn_x\ Fe_{2-2x}O_4$* (x =0.0, 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6) system have been investigated by means of X-ray diffraction, Infrared spectroscopy, magnetization and a.c. susceptibility measurements. X-ray results confirm single-phase spinel structure for all the concentrations. The infrared spectra obtained at room temperature in the range 200–800 cm^{-1} showed two absorption bands. The force constants have been obtained from IR data. The

variation of the saturation magnetization per formula unit as a function of Mn^{4+} content x has been satisfactorily explained.

R. H. Kodama et al [**20**] reported that *Nickel ferrite* nanoparticles exhibit anomalous *magnetic properties at low temperatures*: low magnetization with a large differential susceptibility at high fields, hysteresis loops which are open up to 160 kOe, time-dependent magnetization in 70 kOe applied field, and shifted hysteresis loops after field cooling. We propose a model of the magnetization within these particles consisting of ferrimagnetically aligned core spins and a spin-glass-like surface layer. We find that qualitative features of this model are reproduced by a numerical calculation of the spin distribution.

Despite of many other attempts, there is no specific report on the trivalent substitution of yttrium doped Nickel, Magnesium, Cadmium ferrite nanopowders to the best of our knowledge. Therefore we are interested to investigate the properties of yttrium doped Nickel, Magnesium, Cadmium ferrite by simplest sol-gel autocombustion technique.

3. a) OBJECTIVES OF RESEARCH:

- To choose sol-gel autocombustion method for investigation of the effect of rare earth Yttrium substituted in Ni-Cu nanoferrite.
- To Design, Develop and Installation.
- To synthesize nanocrystalline $Ni_x Cu_{1-x} Fe_2O_4$ where x = 0.1, 0.2,0.3, 0.4,0.5,0.6, 0.7 and 0.8 has to prepare by using metal nitrates, to investigate the properties of Ni-Cu and select the optimize value of 'x' from these to substitute Yttrium in Ni-Cu ferrite by sol-gel autocombustion technique.
- To synthesize nanocrystalline $Ni_x Cu_{1-x} Y_y Fe_{2-y} O_4$ where x = optimize value and y < 0.2 i.e. y= 0.025, 0.05, 0.075, 0.1, 0.125) has to prepare by using metal nitrates, to investigate the properties of Yttrium substituted Ni-Cu ferrite by sol-gel autocombustion technique.
- To Investigating the exact growth mechanism and effect of Yttrium substituted in preparation of nanocrystalline ferrite materials.
- To study the properties of prepared sample using the characterizations Thermo Gravimetric and Differential Thermal (TGDT), X- ray diffraction (XRD), Fourier Transforms Infrared Spectroscopy (FTIR), UV-visible absorption Spectra, Transmission

Electron Microscope (TEM), Scanning Electron Microscopy (SEM) and Vibrating Sample Magnetometer (VSM) for magnetic properties.

- To study the role of various composition of prepared samples to determine the electrical, magnetical and structural properties of the material.
- To study reasons behind the superiority of the samples produced by method.

b) HYPOTHESIS:

Among the various soft chemistry routes, sol-gel procedures were particularly successful in the preparations of bulk metal oxides. (Example: ceramics, glasses, films, and fibers) and therefore they also been used applied for nanoparticle synthesis. But in spite of great efforts, the number of oxidic nanoparticles obtained by Sol-gel chemistry is still rather small compared to the variety of compounds obtained via powder routes. It turned out that in many cases a synthesis protocol developed for a bulk metal oxide could not directly be adapted to its corresponding counter art on the nanoscale.

4. METHODOLOGY TO BE ADOPTED:

The Sol-gel process is the conversation of a precursor solution into an inorganic solid via polymerization reaction induced by water. The metal oxides are most widely used precursor because they react readily with water. The sol-gel process is also called as chemical solution deposition or wet-chemical technique. The sol-gel process is widely used in the fields of materials science and ceramic engineering for the fabrication of metal oxide materials starting from a chemical solution (sol), that acts as the precursor for an integrated network and gel for discrete particles or network polymers.

Sol-gel process consist of following steps

1. Preparation of homogeneous solution of either by dissolution of metal organic precursors in an organic solvent that is miscible with water or by dissolution of inorganic salts in water.
2. Conversion of the homogeneous solution into a sol by treatment with a suitable reagent (Generally water with or without any acid/base).
3. Maintaining the pH as solution by using a liquid (ammonia liquid).
4. By using continuous heat treatment, the formation of gel.

It offers a specific advantage in the precipitation of multi-component oxides ceramics. The early formation of gel provides high degree of homogeneity and reduces the need of atomic diffusion during solid state calcinations. In this precipitation, a solution of appropriate precursors (metal salts or metal organic compounds) is formed first followed by the conversion into homogeneous oxide network after hydrolysis and condensation. Drying and subsequent calcinations of gel yields an oxide product. For preparation, alkoxides are mixed together in alcohol. Hydrolysis can carried out under controlled temperatures, pH and concentration of alkoxides, added water and alcohol. However, the relative high cost of alkoxides may be prohibitive for certain applications.

In this study, Sol-gel method is utilized because of its advantage of good stoichiometric control and the production of ultra fine particles in a relatively short processing time at lower temperatures.

For mass production of Nanocrystalline Ferrite materials, we need a technique which is cost effective and can be easily scaled up. Sol-gel technique meets these requirements and many reports have been already published.

Following **stepwise approach** will be undertaken to achieve the objectives stated in the research proposal.

Step-I: Design, development, and installation of the basic infrastructure namely sol-gel autocombustion technique.

Process: Yttrium nitrate, Ferric nitrate, Nickel nitrate and Copper nitrate are used as a raw material while Citric acid as a fuel to prepare composition of $Ni_x Cu_{1-x} Fe_2O_4$ where x = 0.1, 0.2,0.3, 0.4,0.5,0.6, 0.7 and 0.8, and $Ni_x Cu_{1-x} Y_y Fe_{2-y} O_4$ where x = optimize value and y < 0.2 i.e. y= 0.025, 0.05, 0.075, 0.1, 0.125) using the stoichiomertic ratio. The distilled water is used as a solvent. The solution is stirred for 30 minutes to obtain the homogeneous solution. During constant stirring ammonia solution are added drop by drop up to obtain pH of 7. The solution is continuously stirred with constant temperature 100^0C till it becomes gel form within 3-4 hrs. Approximately after 1/2 hours, the autocombustion takes place and obtain ferrite powder. Then this powder is finely grinded and sintered for the purity then it will be characterization.

Step-II: Synthesis of Yttrium substituted Nickel-Copper ferrite nanocrystalline powder. The dependence on physical properties of the various combinations of nitrate citrates will be investigated.

Step-III: To study the characterization of the $Ni_x Cu_{1-x} Y_y Fe_{2-y} O_4$ at different compositions and sintering temperatures.

Following techniques will be used for the characterization.

i) **Structural properties:**

Thermo Gravimetric and Differential Thermal (TGDT), Fourier Transform Infrared (FTIR) spectroscopy, X-ray diffraction (XRD), Scanning Electron Spectroscopy (SEM), Transmission Electron microscope (TEM) at different sintering temperatures

ii) **Electrical properties:**

AC, DC resistivity

iii) **Magnetic Properties:**

Vibration Sample Magnetometer (VSM)

iv) **Optical Properties:**

UV Spectroscopy

5. IMPORTANCE OF STUDY:

International Status:

Nanotechnology promises to deliver naval product and process or enhance the performance of exciting ones across sectors. They include interventions in a range of domains like water, energy, health, agriculture and environment that could enable solutions to several development related problems we especially in developing countries. Several industry related sectors like electronics, textile, chemicals and IT appears poised to gain from nanotechnology applications. Thus it appears that nanotechnology could impact on social development, economics and businesses the world over. It will be a fruitful exercise to understand the origin of nanoscience and nanotechnology. If we trace the origin of nanoscience and nanotechnology, we can really understand its influence on human life. The DNA molecule, which is the building block of human life, is about 2.5 nm in diameter proving that life begins at the nano level. Tracing back to the invention related to nanotechnology within the context of textiles, it has come to light that the technology related to the manufacturing of nanofibres using synthesis methods is over a century old. The process of dispersing fluid using electrical charges which formed the basis for developing solvent cum electro-spun nanofibres dates back to the year 1902

with the granting of two separate and independent patents on dispersing fluids(US patent 692,631) and Morton was granted a patent for the method of dispersing fluids(US patent 0705691). After couple of decades in 1940, Formals was granted a patent for using electrical charges to develop synthetic threads.

National Status:

The textile industry has focused on two aspects of nanotechnology: 1) Fibers and 2) Finishes. The following issues surrounding the commercialization and application of nanofibres are well known to the industry such as : 1) Productivity; 2) Performance-related characteristics; 3) scale-up and 4) cost. There have been a few developments in recent past to overcome these aforementioned issues. In addition, it is not clear whether the nanotechnology enabled products meet with the consumer expectations with regard to the need for low costs in volume-based commodity textiles sectors. The Inherent characteristics of nanomaterials like high surface area and weight to volume ratio at the building block level will be of great advantages wherever high performance, life and environmental related and uses are involved.

In Our view, the cost of such nano enhanced products will not be an issue in the healthcare, environment, defense, aerospace and advanced technology sectors. Furthermore, Because of dependence of the nano sector on high level research and development and intellectual property protection, developed economies. In addition, because of the nature of the nanotechnology and its size, it gives immense opportunities for small and medium sized enterprises to venture into this field. We endeavor to provide a new, albeit simple, method of classifying nanofibers based on the dispersion process by which they are produced.

Significance of the study:

Nanocrystalline ferrite materials possess properties of both magnetic materials and electric insulator. These properties make ferrites as an important material in many technological applications. These are preferred because of their permeability in the radio frequency region, high electrical resistivity, mechanical hardness, chemical stability etc. There is a growing interest of researchers from last few decades in nanocrystaline ferrites. The properties of these nanocrystalline ferrites particles are considerably different from those of bulk counterpart. The nanocrystalline ferrites can be prepared by techniques. Number of chemical methods was

developed to prepare nanocrystalline ferrites like wet chemical, microwave refluxing, sol-gel, hydrothermal, glass etc. Processing of ferrites has gained tremendous importance in recent times to meet the high performance demands on ferrites in keeping pace with the vast emerging technologies.

Scope:

With the advent of nanotechnology, a tremendous surge in research on miniaturization and high efficiency electronic device is on rise. These modern devices exclusively need soft magnetic materials as its basic magnetic component. Soft ferrite materials are extensively used in inductors which from a basic requirement in high technology areas. Ni-Cu-Y ferrites are adequately suit these demands and considered to shape the future of advanced technology.

Utility:

Ferrite nanoparticles have been the emerging focus of the recent scientific research because of the importance of the nanotechnology. In the present era they have various possible new technological applications in the areas like catalyst, Ferro fluids, and magneto caloric. Refrigeration, light weight transformers, super capacitor and medical diagnosis. Properties of nanomaterials are very sensitive to method of preparation and sintering condition Ferromagnetic materials (Ferrites) are magnetic ceramics which have potential application for making many such as permanent magnets, memory storage devices and for telecommunication equipment purpose.

Applications of Work

The Ni-Cu - Y ferrite is the most important magnetic material used for the manufacturing of

- Multilayer chip inductors.
- Capacitors.
- Magnetic coating.
- With the advent of nanotechnology, a tremendous surge in research.
- High efficiency electronic devices
- Gas sensors

6. PROPOSED WORK PLAN/FORMULATION AND STRUCTURE OF STUDY:

i) First six month(6 Month)

- Literature survey
- Data Collection
- Provision of chemicals for preparation of samples.
- Weighing of ingredients
- Experimental work
- Final sintering of the samples

ii) One Year (12 Months)

- Characterization of powder samples by TGDT technique and analysis for the calculation of various parameters.
- Characterization of powder samples by UV technique and analysis for the calculation of various parameters.
- Characterization of powder samples by X-ray diffraction technique and analysis for the calculation of various parameters.
- Characterizations of powder samples by Infrared absorption technique (FTIR) and analysis.
- Characterizations of powder samples by Scanning electron microscopy (SEM) and Transmission Electron microscopy (TEM) and analysis.
- Course work completion.

iii) One year and six months(18 Months)

- Structural study of the samples.
- Electrical DC and AC conductivity (LCR meter) properties of samples.
- Magnetic study (VSM) of the samples.
- Analysis of Result and Conclusions.
- Writing of research paper.

iv) Two year(After 18 months)

- Thesis writing
- Submission of thesis.

Out Come Expected

- It is proposed to investigate nanoferrite and study of rare earth Yttrium substituted in Ni-Cu nanoferrite by sol-gel autocombustion technique.
- Influence of Yttrium substituted in the formation of phase.
- The exact growth mechanism of Yttrium substituted nanoferrite.
- Influence of various combinations of nitrates-citrate on magnetic, electrical, structural, and optical properties of Yttrium substituted Ni-Cu nanoferrite powder.
- Optimization of the best suitable combination of various compositions.

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CERTIFICATE

This is to certify that the synopsis **"SYNTHESIS AND CHARACTERIZATION OF YTTRIUM DOPING IN Ni-Cu NANOFERRITES BY SOL-GEL TECHNIQUE" prepared** by **MISS. JYOTI BABASAHEB SHITOLE** as a partial fulfillment for the requirement of the degree of Doctor of Philosophy in **PHYSICS.**

Research Guide
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